ROYAL ASTRONOMICAL SOCIETY.

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G. B. AIRY, Esq. President, in the Chair.

George Bishop, Jun. Esq. 39 Portland Place;
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Albert Marth, Esq. Mr. Bishop's Observatory, Regent's Park.

On the Orbit of Comet II. 1854. By Edward Cooper, Esq.

"The following being rather a curious agreement of the parabolic hypothesis with the observations, I send it in the hope that it may be acceptable to the Royal Astronomical Society. The observations are mine on March 30, Paris on April 7, and Mr. Graham's and mine conjoined on April 15th.

Late Comet.

G.M.T. 1854.	α h m s	δ ° ′ ″
March 30·369639	1 22 27·34	+19 37 14·3
April 7·324534	3 7 57·46	13 17 3·9
15·371142	4 13 16·36	5 44 2·4

"Corrections for aberration and parallax were made by the aid of Mr. Graham's first set of elements.

Second Approximation by Mr. Graham.

T. March 24·01376, G.M.T.

	° ′ ″
π	213 50 8·9
Ω	315 28 16·1
i	82 30 17·4
log q	9·442544

Retrograde.

"The corrections of the calculated middle place to reduce it to the observed, are

+ 0″·1 in longitude, and + 0″·3 in latitude.

Observations of Amphitrite, taken with the Meridian Circle at Bonn. By Professor Argelander.

(*Communicated by Albert Marth, Esq.*)

1854.	R.A. h m s	Decl. ° ′ ″	Mag.
March 19	13 5 48·08	−9 44 5·3	9·0
20	4 58·30	41 40·65	9·0
31	12 55 3·84	8 52·6	9
April 2	53 10·85	−9 1 57·6	br. 9
5	50 21·16	−8 51 12·3	9
6	49 24·51	47 32·0	9
9	46 36·95	36 25·9	faint 9
10	45 41·69	32 44·1	9
12	43 52·69	25 14·2	9
13	42 59·01	21 30·8	9
14	42 5·90	17 50·1	f. 9
16	40 21·57	10 28·7	br. 9·0
17	39 30·63	6 52·3	f. 9
18	38 40·73	−8 3 12·0	f. 9
19	12 37 51·31	−7 59 42·2	br. 9·0

On the Final Determination of the Longitude of Cambridge from Observations of Galvanic Signals.

(*Extract of a Letter from Professor Challis.*)

" Soon after the observations were made [in May last year], I communicated to the Astronomer Royal a provisional result, stating, at the same time, that I expected it would subsequently be modified by taking account of the effect of the forms of the transit-pivots. This first result is published in the *Monthly Notices*, Vol. XIII. p. 251. I recently completed the calculation of the corrections to be applied to the transit observations that were taken on May 17 and 18, 1853, for the determination of the true sidereal times of the signals, and have deduced on applying them the subjoined value of the longitude. These corrections were calculated by the method which I have described in the Society's *Memoirs*, Vol. XIX., p. 103, and are the mean results from two independent sets of measures which agreed well with each other. The calculations cost no little time and labour.

East Longitude of the Cambridge Observatory.

Method (A).

	s
May 17, By 146 signals	22·660
18, By 135 signals	22·713
Mean	22·687

Method (B).

	s
May 17, By 146 signals.....	22·601
18, By 135 signals	22·782
Mean.....	22·691
Mean of the whole.....	22·689

"Slight errors made in the first calculation being taken into account, the effect of the forms of the pivots is to make the longitude less eastward by $0^{s}\cdot32$. I propose hereafter to adopt $22^{s}\cdot69$ east for the longitude of the Cambridge observatory."

Errata in Weisse's Catalogue and in Lalande.

"The following particulars will show that observers may be put to considerable inconvenience by the imperfection of catalogues:—

"1854, May 8. Weisse xi. 552 was selected for comparison with *Bellona*. No star agreeing with the place of the catalogue is to be found in the heavens, nor in the original zones; but in zone 225 there is a star of the same R.A., and of equal *south* declination, viz. $-12^{\circ}\ 24'\ 24''\cdot1$.

"1854, May 16. No star to be found in the place of Weisse xv. 259, which was selected for comparison with *Thalia*. By reduction from the original zones it appeared that the declination should be $-13^{\circ}\ 17'\ 8''\cdot8$. The star is therefore the same as H.C. 28009.

"1854, May 23. In an attempt to observe *Euterpe* by means of H.C. 13739, no star could be found in the place of the catalogue. J. Challis.

"*Cambridge Observatory, June 2, 1854.*"

"The singular phenomenon of a mock moon was visible here on last Thursday evening, 30th March. The evening was perfectly clear and free from all apparent vapour, and as the sun went below the horizon the stars shone forth with the greatest brilliancy. About seven, being on the open fields, and turning to look at the moon, I thought it was larger than usual; and upon stedfastly looking at it, I distinctly saw the light of two moons bearing the following appearance, there being between the two space to the eye of about six inches — the reflected moon giving forth slight motion or shooting effulgences similar to the aurora borealis; whilst above, the whole disk of the moon became quite visible. Many persons saw the same, their attention being called to it, and watched the setting of the moon and its companion in the far west. C. E. Walker.

"*Rectory, Clyst St. Lawrence, Devon.*"

On the Observatory at Stone Vicarage, near Aylesbury.
By the Rev. J. B. Reade, M.A., F.R.S.

As the advowson of the living of Stone has been presented to the Council of the Astronomical Society, it may be desirable, for the purpose of future reference, to place in the Society's archives a short account of the Observatory which has recently been erected on the vicarage lawn.

This Observatory, without any pretension to accurate architectural detail, is an elegant Grecian building, consisting of a transit-room and a tower for the equatoreal. On the site, selected by Admiral Smyth, which commands the passage of α *Columbæ* to the south, and the lower transit of α *Cygni* to the north, 9-inch brick walls, surrounded by an air-drain 2 feet deep by 18 inches in width, were raised on a solid mass of concrete, resting on a natural bed of compact Kimmeridge clay. The transit-room is 11 feet in length, 10 in breadth, and 10 in height, having a flat roof covered with sheet lead. The slits in the north and south walls are 18 inches wide, and reach down below the level of the telescope. The vertical portion of the slits is closed by glazed windows, with shutters outside to exclude the solar rays, and the continuous portion through the roof is fitted with a north and south wooden flap, covered with copper, and opened by rods resting on suitable sockets. The floor is supported on strong joists forming square frames around the transit and clock bases, which are of solid masonry, whilst a free circulation is secured beneath by means of small iron gratings in the walls and air-drain. Three steps to a doorway in the eastern wall lead into a circular room nearly 14 feet in diameter, containing the polar axis, to which the large refractor is attached by an equatoreal mounting; and the wall-plate is capped by an iron channel containing balls of the same metal 4 inches in diameter. The conical dome of well-seasoned Riga fir, cut with the grain, and jointed together with thin laths, was formerly at Bedford, and will always be an interesting relic to those who can appreciate Admiral Smyth's most valuable contributions to astronomical science. It is pleasant now to hear the Admiral describe, under his old dome, where he rode at anchor, the results of his untiring labours; and the resolution with which he passed night after night in the measurement of double stars, never forgetting, to use the words of Shakspeare, his "bright particular star," γ *Virginis*, makes his motto, "Mors aut gloria," almost as applicable to his astronomical as to his naval exploits.

The transit instrument is supported on solid piers of Bath stone cut from a single block, which was purchased many years ago for the Observatory at Hartwell. The object-glass, $4\frac{1}{4}$ inches in diameter and 6 feet in focal length, is an interesting specimen of the skill of Mr. Peter Dollond; and Mr. Barrow, of Oxenden Street, has spared no pains in making the brass-work mounting very strong and of the most approved construction. The transit observations are entered and reduced on the plan adopted at Greenwich.

The object-glass of the equatoreal, 7·3 inches in diameter and 12 feet in focal length, is by Mr. Newman of York, and it well repays the large amount of labour both of calculating and grinding the proper curves. The flint-glass in the rough was purchased by Wm. Tulley for 70*l.*, and Mr. Chance of Birmingham supplied the glass for the crown lens. When the aperture is diminished to about 6 inches, it bears well the *experimentum crucis* of good workmanship, as it shows the concentric rings with equal distinctness when the eye-piece is placed on either side of the focus. Its "*space-penetrating power*" may be judged of by the precision with which the 5th and 6th stars in the trapezium of *Orion* are brought out. The surfaces, however, are not worked up to the highest polish, and there is consequently a felt loss of light when the deeper powers are applied.

The equatoreal mounting made under the direction of Mr. Gravatt by the village carpenter, Mr. George Carter, is generally similar to that adopted by Dr. Lee and Mr. Bishop, but the large 6-feet declination circles, of which one is fixed to the polar axis, and the other to the frame-work of the telescope, are of wood. Rhomboidal bracings of wood attached to the latter circle, and reaching from the object to the eye-end of the telescope, have received the unqualified approbation of many practical astronomers; and their construction is well shown in the beautiful model of the Observatory which accompanies this paper, and which has been made by Mr. Charles Carter, the son of the village carpenter before-mentioned.

The declination axis with the large iron cradle, in which the telescope lies, as well as the pivots and iron-work at either end of the axis, is the work of Mr. Donkin. The box of the declination axis is *square*, and not round, as is usually the case, and, in order to command a most important adjustment, it is inserted into a nearly square hole in the polar axis (the longer side being in the direction of the length of the axis), so that by means of a couple of wedges driven into this hole towards each end of the axis, the parallelism of the axis of the telescope and of the polar axis is perfectly attained. In this position the telescope points to the true pole during the whole revolution of the hour-circle, and the adjustment once made, can never be disarranged except by violent strain.

The telescope is furnished with a position wire micrometer by Tulley, and the usual range of astronomical powers; and an hour-circle, to be driven by clockwork, will be added by Mr. Whitworth of Manchester.

A complete set of meteorological instruments has been obtained under the direction of Mr. Glaisher, and monthly observations are regularly forwarded to the Registrar-General.*

* With respect to the achromatism of my solid eye-piece, which obtained a prize-medal at the Exhibition, Mr. Dawes says, in a note just received: — "I have only time to say that, compared with a Coddington lens, which I have, and which, curiously enough, happens to be of precisely the same focal length,

The *latitude* of the Observatory determined by a Troughton's reflecting circle is 51° 47′ 57″·0 north, and the *longitude*, from simultaneous observations of moon-culminating stars at Oxford, Cambridge, and Hartwell, is $0^h\ 3^m\ 29^s{\cdot}09$ west.

The following is a general statement of the cost of the building and of the instruments, Dr. Lee having most handsomely presented 15,000 bricks, as well as the piers and dome :—

	£	s.	d.
Bricklayer and stonemason	51	4	6
Carpenter	75	6	1
Mr. Gurney, for wood	47	10	6
Plasterer	25	14	0
Plumber and glazier	28	12	0
Iron-work	16	1	2
	£244	8	3

	£	s.	d.
Timber and work for polar axis	24	19	9
Declination axis	19	0	0
12-Foot refractor	100	0	0
Transit instrument	80	0	0
Meteorological instruments	20	0	0
	£243	19	9

The whole expense, consequently, amounts to £488 8*s*.

Stone, May 9, 1854.

Occultation of Mars observed at Highbury. By T. W. Burr, Esq.

"1854, March 12th. This occultation was observed with my 4-foot equatoreal with power 173.

	h	m	s	
The Immersion began at	14	33	19	Sidereal Time.
The Immersion complete at	14	34	17	
The Emersion complete at	14	58	38	

"The observation of the first contact is a little uncertain, probably 1^s too late, it being difficult to detect the earliest impression made on the planet's limb. The complete eclipse was very accurately noted, as also the complete emersion. The reappearance of the first limb was lost while changing an eye-piece. The time was

and giving ∴ both of them a power of 358 on a telescope of 102½-inch focus, your solid achromatic has the advantage of being almost entirely free from colour throughout the field, which, though small, is quite equal to that of the Coddington, when the eye-hole is removed from your lens. The eye-hole is too small, not admitting oblique pencils, which are very pure and good; though it is large enough to admit all the rays which come from the object-glass nearly direct." "The smallness of the field (for deep powers) may prevent this from being in general a desirable form for a micrometer eye-piece, though it may prove, when carefully constructed, an agreeable and efficient one for delicate scrutinies of small objects."

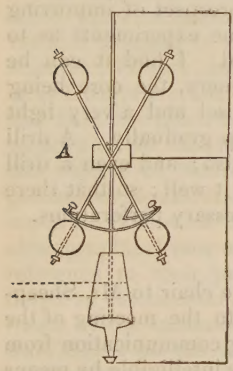
corrected by a transit of α^2 *Libræ*, taken during the occultation. No projection of *Mars* on the moon's disk was seen or other anomalous appearance. The definition was very fine, the configuration of the planet's surface being traceable to the last moment of eclipse by the moon's limb without any diminution of sharpness which would have been the case with an extensive lunar atmosphere."

Notes on Experiments relative to Lunar Photography and the Construction of Reflecting Specula. By the Earl of Rosse.

(*Extract of a Letter from the Earl of Rosse to the Astronomer Royal.*)

"As you mentioned to me in one of your letters that the Astronomical Society would be glad to hear from time to time what we are doing, there are two or three little matters I have been recently engaged in which may, perhaps, interest them.

"First, as to lunar photography. I have constructed a smooth motion-clock to carry the plate of glass, and its performance is satisfactory. The regulator is thus made: there are two levers with balls on the extremities, which exactly balance in *every position;* they are acted upon by two springs with screw adjustment, and on the expansion of the balls the regulating friction takes place at the ring A.* The object was to obtain a regulator independent of position. The direction of the motion of the glass plate is regulated by an adjustable slide, and we set the slide by trial, not by a table computed for the purpose. To set the slide, an eye-piece, with lines truly parallel to the slide, is inserted. By such means a pretty picture of the moon can be obtained, but at present I believe there is no known photographic process which is sufficiently sensitive to give details *in the least degree* approaching to the way in which they they are brought out by the eye. The application of such a smooth motion-clock to instruments *not equatoreally* mounted, may, perhaps, be important, as it affords great facilities for the use of the micrometer. With our 3-foot telescope, I have no doubt, excellent micrometric measures might be obtained; and with a somewhat enlarged small speculum, there would be ample time without hurry. For all objects but the moon, a table might be constructed with little trouble for setting the slide, which would save time.



"You recollect, no doubt, how greatly superior silver would be to speculum metal, if it could be as well and as easily polished as speculum metal. At the Ipswich meeting of the British Association

* The crossed rods pass in the inside of a ring and rub the inner edges of the ring.

I described a process which had been, to a certain extent, successful. It is difficult, however, and uncertain; and as a silver surface, is very perishable; it would scarcely be worth while to employ it, except under special circumstances.

"Another method which I have very recently tried is perfectly easy, and promises well. A plate of glass is coated with silver by precipitation from saccharate of silver. The silver film is then varnished with tincture of shell-lac, and when dry the temperature of the glass is gradually raised to the fusing point of shell-lac. Pieces of shell-lac are then laid upon it, and over them a piece of thick glass. A slight weight presses out the superfluous shell-lac, and the whole having gradually cooled, the silver film adheres permanently to the shell-lac, the glass upon which it had been originally precipitated being easily removed without injuring it. We have thus a silver surface apparently as true as the glass upon which it had been precipitated, and with a beautiful polish. The experiment is imperfect so far as this, that as yet merely common plate-glass has been tried, and not a true glass surface; and as I am about to set out for London, I shall have no opportunity for some time of completing these experiments.

"With the view of applying Mr. Lassell's levers to one of our 6-foot specula, should there be a reasonable prospect of improving its performance in that way, I have tried some experiments as to the practicability of drilling speculum metal. I find it can be drilled by a tubular drill of soft iron and emery, the core being from time to time removed by a pointed chisel and a very light hammer, by which it can be safely broken up gradually. A drill with diamonds set in a groove cuts it well also; and even a drill of perfectly hard steel, revolving slowly, cuts it well; so that there can be no serious difficulty in making the necessary perforations.

"*Castle, Parsonstown, April 20th*, 1854."

The Astronomer Royal having resigned the chair to Mr. Sheepshanks, proceeded to give a full explanation to the meeting of the various experiments alluded to in the foregoing communication from Lord Rosse, his remarks being rendered readily intelligible by means of models, which he had caused to be constructed for the purpose of illustration, and which had been obligingly forwarded by him to the Apartments of the Society. He pointed out the advantage which the system of supports for resisting edgewise pressure, now proposed by Lord Rosse, would have over that of Mr. Lassell, of which it was a modification, namely, that in the case of a reflector being mounted equatoreally, it would prevent the possibility of undue pressure against the *side* of the supporting-ring during the period when the telescope was being pointed to a celestial object; whereas in Mr. Lassell's system the supports come into their proper operation only after the position of the speculum has been rectified by rotating the tube in its cradle: this is a point of great importance in large specula, as it is found that they do not immediately recover their normal figure after distortion by pressure. At the same time, he

took occasion to repeat that he still thought it preferable to avoid the rotation of the telescope tube in its cradle altogether, which the altazimuth mounting he had proposed would effect, and yet still provide for an equatoreal movement in the telescope, although he was aware that Mr. De la Rue was of opinion that the difficulties of mounting very large telescopes on an equatoreal stand might be overcome. The Astronomer Royal also pointed out, that if such a mounting were adopted, it would be desirable to so construct the system of supports for resisting the pressure perpendicular to the surface of the mirror, as to admit of the fulcra of the levers for resisting edgewise pressure being carried by them, in order that the ends of the levers might support the pressures in all directions equably, without constraining the mirror in any way, and without impeding its change of position by any sensible friction.

The Mediterranean: a Memoir Physical, Historical, and Nautical. By Rear-Admiral William Henry Smyth, K.S.F., D.C.L. &c. &c. 519 pp., 8vo. London: John W. Parker and Son. 1854.

In this volume Admiral Smyth has presented the results of many years of personal observation and research in the Mediterranean, bringing to the aid of his labours a vast amount of valuable scientific, literary, and antiquarian lore. As a contribution to Physical Geography, the merits of this work are obvious at first sight, and have not failed to be duly appreciated by the most competent authorities on the subject; but it is no less calculated to advance the objects of Nautical Astronomy, considered in its most comprehensive signification as a branch of mathematical and physical inquiry. The work is divided into five parts. Part I. contains a chorographical view of the shores of the Mediterranean, with especial reference to their produce and commerce. This may be considered as introductory to the scientific part of the work. Part II. treats of the currents, tides, and waters of the Mediterranean Sea. Part III. is on the winds, weather, and atmospherical phenomena of the regions of the Mediterranean. In Part IV. the author gives an interesting account of the early surveys of the Mediterranean, and concludes with an exposition of his own labours, having for their object the improvement of the existing state of knowledge on the subject. The valuable character of Admiral Smyth's Marine Surveys, — which extended over the interval comprised between the years 1810 and 1824, — was soon recognised by the Admiralty, who caused charts of them to be engraved and published, which have been long in general use. In the fifth and concluding part of his work, the author gives the determinations of the Maritime Positions upon which his charts were based. It contains

* In connexion with these remarks, the reader may consult with advantage the substance of a lecture delivered by the Astronomer Royal on the large reflecting telescopes of the Earl of Rosse and Mr. Lassell, which is publishd in vol. ix. of the *Monthly Notices* (p. 110, *et seq.*).

the longitudes and latitudes of about 1500 points distributed on the coasts of Spain, France, Italy, &c. &c. The remarks accompanying each determination are expressed by means of symbols, which are the same as those used by Lieut. Raper in his well-known treatise on the Practice of Navigation. The Admiral suggests the expediency of introducing a few additional symbols, but he assigns to his friend, Lieut. Raper, the execution of this task on the occasion of publishing the next edition of his standard work.

Die Wunder des Himmels oder gemeinfassliche Darstellung des Weltsystems. Von J. J. von Littrow. Vierte Auflage. Nach den neuesten Fortschritten der Wissenschaft beurbeitet von Karl v. Littrow, Director der Sternwarte zu Wien, &c. &c. 8vo. (pp. 833), Stuttgardt, 1854.

J. J. von Littrow's Atlas des gestirnten Himmels fur Freunde der Astronomie. Zweite vielfach verbesserte und vermehrte Auflage, herausgegeben von Karl von Littrow. Stuttgardt, 1854.

The work on popular astronomy by the late Professor Littrow has long been much esteemed in Germany, as is proved by the appearance of four successive editions. The present edition has been adapted to the existing state of astronomical science. The work is divided into four parts. The first part treats of theoretical astronomy; the second part is upon descriptive astronomy and the topography of the heavens; the third part is devoted to physical astronomy; and the fourth is upon the description and use of astronomical instruments. The Atlas above entitled forms a suitable accompaniment to the work.

Report of the Astronomer Royal to the Board of Visitors, read at the Annual Visitation of the Royal Observatory, Greenwich, 1854, June 3.

The present Report to the Board of Visitors may be understood as recording the general condition of the Observatory on 1854, May 26, and the transactions from 1853, May 22, to that time.

Grounds and Buildings.—I alluded in the last Report to the necessity for a new fire-proof room. The want of this became so evident that in the last autumn I submitted to the Lords Commissioners of the Admiralty a proposal for constructing one in the present year; and in consequence a sum of 550*l.*, applicable to that purpose, has been granted on the Navy Estimates. The plan has been arranged in concert with Lieut.-Colonel Greene, R.E., civil architect of the Admiralty. * * * *†

Astronomical Instruments.—The transit-circle has not received or required any alteration. Its efficiency is perfect.

The new mounting of the quicksilver-trough, to which I alluded

† Several entire paragraphs are here omitted: the same is to be understood of those other parts where asterisks occur.

in the last Report, is in use, and is found advantageous, as I expected. It has required a new crane cistern for the store of quicksilver. Troughs both of iron and copper are adapted to the mounting, and sometimes one and sometimes the other is employed, according as the observer prefers to submit to the inconvenience of tremor with the iron trough, or loss of light with that of copper.

The transit-circle for the Cape Observatory, at the last advices, had been safely received at the Cape, but was not mounted.

The reflex zenith-tube is in general good order, and is, generally speaking, perfectly efficient. Still I think that its efficiency will be improved, as regards both the number and the excellence of the observations, by transferring it to a site where it will be less subject to tremor.

The altazimuth is in the same state as in the last years, and is completely efficient. Still I cannot deny that, with the experience that I have gained in the construction of the transit-circle, I could now construct a better altazimuth—better, however, rather in convenience than in accuracy. In the particular point which I mentioned in my last Report (the counterpoise friction-wheels of the horizontal axis), I still contemplate a change.

The barrel apparatus for the American method of transits has been practically brought into use; not, however, without a succession of difficulties, arising from causes sometimes very hard to discover. When the instrument was approaching to a serviceable state, there still remained an imperfection in the ill-defined form of the punctures on the paper. At this juncture, Lieutenant Maury, U.S.N., paid me a brief visit, and in the course of inspection of the instruments he alluded to this very defect, and to the method which had been used in America for its remedy. Although my apparatus did not admit of the same application, yet, possessed of the principle, I had no difficulty in embodying it in a form adapted to my wants; the prickers were mounted on springs, and now the punctures are perfectly round. The paper on which the punctures are to be made is folded in a wet state, upon a brass cylinder covered with a single thickness of tailor's woollen cloth, and has its edges united by glue.

The punctures, it will be remembered, are produced by two systems of prickers, which have nothing in common except that they are carried by the same travelling frame, which moves slowly in the direction of the barrel-axis while the barrel revolves beneath it. These require separate notice.

One pricker is driven by a galvanic magnet whose galvanic circuit is completed at every second of sidereal time. It was at first intended by me that the completion of the circuit should be effected by the same smooth-motion clock (regulated by a conical pendulum) which drives the barrel. I found, however, that I could not ensure such a constancy in the radial arc of the pendulum as would make its rate sufficiently uniform to entitle it to be considered as the fundamental clock; and, moreover, there was a little difficulty in referring its indications to those of the transit-clock

(which must be used in some cases). I, therefore, carried wires from the pricker-magnet to the transit-clock, connected there with springs whose contact is made at every second by the transit-clock. At first the contact was made by the touch of a pin fixed in the pendulum-rod; and this construction for a time answered well. But it so happens that, in our transit-clock, the pendulum is carried by one frame, and the point of attachment of the galvanic springs by a different frame: it was impossible to maintain these in steady adjustment; and the rate of the clock was sensibly disturbed. I have now adopted the following construction, which promises to succeed better. A wheel of 60 teeth is fixed on the escape-wheel axis, and the teeth of this wheel in succession make momentary contacts of the galvanic springs. The position of the springs is so adjusted that the effort of the wheel-tooth upon them occurs only when one escape-tooth has passed the sloping surface of the pallet, and the other escape-tooth is dropping upon its bearing; and thus the resistance of the springs does in no way affect the legitimate action of the train upon the pendulum.

The other pricker is driven by a galvanic magnet, whose circuit is completed by an arbitrary touch made by an observer's finger upon a contact-piece. Of contact-pieces there are three. One is upon the eye-end of the transit-circle: it effects the contact of two brass rings which (by means of wires passing in the interior of the tubes) are connected with two other brass rings surrounding the axis and touched respectively by two springs on the pier leading to the galvanic wires. The other two contact-pieces are upon the rotating base-plate of the altazimuth (one to be used with vertical face to the right, the other with vertical face to the left); the parts which they bring together carry springs which touch two large horizontal rings on the fixed base; and these rings are connected with branches of the same pair of wires which communicate with the altazimuth. Thus altazimuth observations are referred absolutely to the same time-record as transit-circle observations.

It is necessary to mark upon the revolving barrel the beginnings of some minutes and the numeration of some hours and minutes. This is done by arbitrary punctures given by the observer's touch, upon a simple system which scarcely merits detailed description.

In order to guide the eye through the multitude of dots upon the sheet, lines of ink are traced by means of a glass pen, which is attached to the same frame as that by which the prickers are carried.

Wires have been inserted in the wire plates, both of the transit-circle and of the altazimuth, at intervals adapted to the rapid observation by touch. The wires of the transit-circle and the vertical wires of the altazimuth are adapted to intervals of about 42″ and 48″ of arc; the intervals of the horizontal wires of the altazimuth do not exceed 24″ of arc. They are probably the smallest intervals that have ever been used. The old systems of wires are not disturbed, nor rendered confused; so that, with the transit-circle, either 7 wires may be observed by ear, or 9 by touch; and

with the altazimuth (in either dimension) either 6 by ear or 6 by touch.

I have only to add that this apparatus is now generally efficient. It is troublesome in use, consuming much time in the galvanic preparations, the preparation of the paper, and the translation of the puncture-indications into figures. But among the observers who use it there is but one opinion on its astronomical merits; that, in freedom from personal equation and in general accuracy, it is very far superior to the observation by eye and ear.

The galvanic apparatus for giving time-signals, for dropping the time-ball, and for maintaining the movement of sympathetic clocks, is in the same state as at the last Report, with this addition only,—that a separate battery, galvanic needle, and pair of contact springs, are appropriated to the wire on which the current is sent to drop the time-ball at Deal at 1^h (the contact being completed by the same movement of a galvanic magnet which drops our own ball), and that the fall of our ball-tumbler then effects such a change in the connexions of the wires, that the galvanic needle is in a state fit to receive the return-signal given by the Deal ball when it reaches the end of its fall.

The hour-circle microscopes of the north, or Shuckburgh's equatoreal are in Mr. Simms's hands for alteration. In other respects, the equatoreals, micrometers, &c., are in their usual good state. Preparations have been made for attaching a photographic apparatus to the east, or Sheepshanks' equatoreal.

The old instruments of the Observatory have been preserved almost untouched since the last meeting of the Visitors.

Observations.—The long-established plan of meridional observations is preserved unaltered in its essential points. The standard stars of the extended list, as well as those of the *Nautical Almanac* list, are observed (the latter twenty times in three years, if possible), and all the bodies of the solar system at every opportunity (the moon only being observed on Sundays). The whole number of observations from 1853, May 22, to 1854, May 26, is nearly as follows (an observation of two limbs, or a duplicate transit by eye and by touch, being counted as two):—In the transit department: transits, 4802; observations of collimators, 317; observations of transit-wires by reflexion, 317; observations of one collimator by the other, 53. In the meridian-circle department: observations of all kinds, 4590.

The intervals of transit-wires have been determined by collimator-observations when it appeared necessary.

The ordinary routine of transit-observations is the same as last year. Of clock stars and planets it is unnecessary to speak: the adjustment-observations are,—weekly comparisons of collimators, daily observations of collimators with the transit-telescope and of the wires by reflexion, observations of circumpolar stars when possible. It has been necessary to add to these, comparisons of the transits by ear and by touch, as the ear-observation must be used still for the very slowly moving stars.

For the circle adjustments, there are weekly observations of runs of microscope-micrometers, daily observations of the wire by reflexion, and observations of stars by reflexion when practicable.

With the reflex zenith tube, observations of *γ Draconis* have been obtained on 39 days. The principle of using quicksilver in a copper pan has not been adopted here.

The observations with the altazimuth have been conducted as in the last two years. The number of days of complete observations of the moon is 209, or 16·7 per lunation, against 117 with the transit circle, or 9·4 per lunation. Of the altazimuth observations, 0 are when the moon passed the meridian between 0^h and 1^h, 3 between 1^h and 2^h, 9 between 2^h and 3^h, 5 between 21^h and 22^h, 0 between 22^h and 23^h, 1 between 23^h and 24^h. There is only one corresponding observation on the meridian, namely, between 2^h and 3^h. The whole number of separate observations of moon and stars with the altazimuth is 976; and the whole number of separate observations of its collimator, 712.

The equatoreals have been used for observing the third comet of 1853, and the great comet of 1854. The former observations do not, perhaps, possess any particular value. No observations have been made on the solar spots.

The double-image micrometer has been used for measures of *γ Virginis* (two evenings), and of *Saturn's* rings (six evenings).

Reduction of Observations.—Although our reductions are in a perfectly healthy state, quite complete in everything that demands judgment and recollection of the circumstances under which the observations were made, and now requiring only masses of mechanical calculations, yet they are not so forward as I could wish. They are, however, almost more forward than I could expect; for very much time has been consumed in general galvanic arrangements, in the arrangements for the galvanic drop of a time-ball at Deal, in the reducing to practical efficiency the American method for transits, and in the operations for the longitude of Brussels; and very much time also in the reading of the great number of proof-sheets lately received. The maintenance of our computations, under these circumstances, in a forward state, is due almost entirely to the skilful and orderly arrangements and the unwearied personal attention of Mr. Main.

For transits, the clock times of true transits are formed to May 13; the apparent right ascensions from observation to May 12; the star corrections are computed to May 20, and are applied to March 5. For the circle observations the concluded circle readings are completed to May 20; the apparent zenith distances to May 6; and the north polar distances from observation to April 1. The star corrections are computed to April 1, but are not yet applied.

The observations with the reflex zenith tube are reduced to May 19.

With the altazimuth, the zenith distances are completely reduced to April 20, and the azimuths to Feb. 22; the tabular computations of zenith distance and azimuth are complete to

March 17; and the errors of zenith distance and azimuth are converted into errors of R.A. and N.P.D. to the end of 1853. The results are very satisfactory.

The observations with the double-image micrometer are fully reduced.

For 1853, the means of the star-places in ledger are completely or very nearly finished, but the star-catalogue is not commenced. No effective work is done to the solar, lunar, and planetary reductions, beyond the formation of the separate errors in R.A. and N.P.D.

As soon as the observations of 1853 shall be sufficiently reduced, I propose to prepare a new star-catalogue, based on the six years' observations from 1848 to 1853.

Printing of Astronomical Observations.—I stated in my last Report that the printing of the Observations for 1852 was scarcely commenced at the time of the last meeting of the visitors. For a long time the printing went on so slowly that I almost despaired of ever again seeing the Observations in a creditable state. After a most harassing correspondence, the printers were at length persuaded to move more actively, and for some time the printing advanced at the rate of five sheets per week. This, of course, has contributed greatly to bring the press-work into proper condition; but the volume is still very much behind its usual time of publication.

The astronomical part is (with the exception of a small part of the introduction) finished. The magnetic results are printed as far as the month of May.

Two appendixes are printed, which I trust the visitors will regard with interest. One is, an elaborate description of the transit-circle, illustrated with sixteen plates. The proofs of the plates have been received, but they are not finally passed for working off. The other is a statement of the regulations, public and private, of the Royal Observatory. These were drawn up in consequence of an application of a foreign State to the British Government; and the Lords Commissioners of the Admiralty ultimately decided that the paper should be printed for public reference.

A large quantity of the manuscripts of observations and reductions for 1853 is prepared for the printer, and has recently been forwarded to him for printing. * * * *

Printing of Magnetical and Meteorological Observations. — The magnetical indications are printed to the end of May 1852. No other part of this section is printed for 1852: the whole of the manuscript is in the printer's hands.

Under this head I may appropriately record the efforts that we have made for multiplying copies of our photographic registers. The subject had long been in our contemplation, and some apparatus, suggested by a gentleman to whom we are very greatly indebted for the efficiency of our photographic operations, had been long since prepared. For some time, perhaps, I trusted too much to the assistance which might be obtained from persons

extraneous to our own establishment. In the last winter, however, Mr. Glaisher took up the matter with his usual vigour. It was soon found that by the agency of the sun-light upon the back of an original photograph, whose face was pressed closely by means of a glass plate upon proper photographic paper below, there would be no difficulty in preparing negative and inverted secondaries, and, from them, positive and erect tertiaries. The process is so simple, and admits of repetition to such an extent, that it may be considered infallible; and all that was requisite was, that the primaries should be good. By diminishing the quantity of iodide of potassium in the preparation of the paper; by slightly touching the dark curves, as soon as they are brought out, with nitrate of silver; and by diminishing the quantity of hypo-sulphite of soda; very pure grounds with black lines are obtained. The sheets are fitted up with their apparatus of time-scales, base-lines, &c., and are then waxed: secondaries and tertiaries are taken from them; and the last, if the operation is properly conducted, are in every respect as good for ulterior uses as the originals. Beyond the trouble to ourselves (accompanied with some small expense) of making secondaries, and the expense of making tertiaries through the instrumentality of some professional person, I anticipate no difficulty in multiplying copies to any extent which the visitors may desire.

Chronometers, Communication of Time, and Operations for Longitude.—The number of chronometers now on hand is about sixty, of which sixteen are makers' chronometers on trial. The chronometers are rated daily or weekly; the trial-chronometers are rated in heat and in cold; the abstracts of rates are formed; and the repairs are superintended, as in former years.

The normal-clock, with its small adjusting apparatus (described in last year's Report), has been in constant use, and has been found exceedingly convenient. It drops the Greenwich ball and the Strand ball, it sends daily signals along several railways, and it maintains in sympathetic movement several clocks by galvanic currents. Among other clocks thus moved, one is in the chronometer-room, one is at the entrance gate, and one is at the South-Eastern Railway Offices, London Bridge.

With the sanction of the Commissioners of Greenwich Hospital, it has lately been arranged by the Rev. George Fisher and myself that two wires shall be swung across the lower part of Greenwich Park, from the top of the Octagon Room of the Royal Observatory to the Observatory of the Hospital Schools, for carrying the galvanic currents which will maintain the movement of a sympathetic clock at the School Observatory.

I alluded, in my last Report, to the erection of a time-signal ball at Deal, to be dropped every day by a galvanic current from the Royal Observatory. The ball has now been erected by Messrs. Maudslays and Field, and is an admirable specimen of the workmanship of those celebrated engineers. The galvanic connexion with the Royal Observatory (through the telegraph wires of the South-Eastern Railway) is perfect. The automatic changes of

wire-communications are so arranged that, when the ball at Deal has dropped to its lowest point, it sends a signal to Greenwich to acquaint me, not with the time of the beginning of its fall (which cannot be in error), but with the fact that it has really fallen. The ball has several times been dropped experimentally with perfect success; and some small official and subsidiary arrangements alone are wanting for bringing it into constant use. I can scarcely convey to the Visitors how much I am indebted to the South-Eastern Railway Company and the Electric Telegraph Company, and to their principal telegraph officers, Charles V. Walker, Esq. and Latimer Clark, Esq., for the liberality and even the zeal with which they have assisted me in every step of these preparations. Without the cordial aid of Mr. Walker, in particular, it would have been impossible to complete the work. The best line of wires on the railway has been devoted to this purpose, and the shifting connexions have been modified to diminish the resistance and remove the chances of disturbance as much as possible.

No step has yet been taken for the galvanic determination of the longitude of Oxford Observatory, although I believe that the preparations within that building are now complete.

The determination of the difference of longitude with the Paris Observatory had long been contemplated as one of the important uses of our galvanic connexions. In the last summer and autumn, I recommenced correspondence with Messrs. Arago and Laugier for this object; and one of my letters to M. Arago was addressed to him on the very day of his death. Deeply do I grieve that this operation was not finished in time for him to know the results: not a day, however, had been lost in pressing it forward. It was obviously impossible then to proceed with it; and I considered myself at liberty to take measures in concert with M. Quetelet for our difference of longitude with Brussels. The Submarine and European Telegraph Company, through an unusually protracted operation, gave their warmest assistance. A most able assistant from the Brussels Observatory, M. Bouvy, came to Greenwich, and Mr. Dunkin went to Brussels: when the operation was half finished, the observers returned to their original posts. The signals were continued every night (an hour each night) until three nights' signals had been obtained, accompanied with unexceptionable transits, in each part of the operation; and these alone were retained as available for longitude. Thus, about 3000 effective signals were made, but only 1000 of these were admissible for the fundamental objects of the operation. The result, I need scarcely remark, claims a degree of accuracy to which no preceding determination of longitude could ever pretend. I apprehend that the probable error in the difference of time corresponds to not more than one or two yards upon the earth's surface.

One of the earliest steps taken by M. Le Verrier, after his appointment to the charge of the Observatory of Paris, had reference to the determination of our longitude-difference. All important preliminaries are now arranged, and I trust to be able to report

orally to the Visitors the commencement, or probably the conclusion, of this long-desired operation.

The perfection of our galvanic connexion with Edinburgh having been fully established by the operations of last year, I had proposed to use it for the determination of the longitude of a more distant point. For checking the azimuthal accuracy of our great National Survey, as well as for giving (by interpolation) the error of longitude of every point of our coasts, I had intended to determine with the utmost accuracy the longitude of Lerwick, in Shetland. I proposed to establish a galvanic connexion with a comparing-observatory on the Granton Pier, and to transmit the time from that point to a selected station in the neighbourhood of Lerwick, by a large number of chronometers carried in the steamboat which plies between Granton and Lerwick. With the sanction of the Admiralty, a grant of money for defraying the expenses was inserted in the Navy Estimates; and other preparations were made. Unfortunately, the demand for chronometers caused by our large naval armament has been so considerable that I cannot reckon on having at my disposal a sufficient number to carry on this operation successfully; and I have, therefore, unwillingly deferred it to a more peaceful time. * * * *

General Remarks.—The past year has, on the whole, been felt as a laborious one. This has arisen from a cumulation of several perfectly distinct causes. The order of our printing has been disturbed, and this has produced great disarrangement of all our ordinary daily work. The establishment of our galvanic system, and its application to American transits, to public time-signals, and more especially to the longitude-determination, has caused to the establishment in general, and to myself in particular, a great consumption of time. The preparation of the Observatory Regulations, and of the Description of the Transit-Circle, and the closing of the business of the Standard Commission, have required a great amount of writing which could be intrusted to no one but myself.

I may confidently hope that in the next following years several of these causes will not be in action. Still I am impressed with the feeling that the strength of our establishment is now loaded to the utmost that it can bear. A brief review of the progress of the science of astronomy and of the arts related to it will show that this must be expected. The number of known planets has been largely increased: and I cannot think that in this National Observatory the neglect of any one of the bodies of the solar system is permissible. The American method of transits adds to our labours; but it appears likely to contribute to accuracy, and it will give facilities for the record of the observations made at other observatories, upon our registering-barrels; and, if these advantages are established by experience, the method must be maintained. The public dissemination of accurate time brings some trouble; but it is a utilitarian application of the powers of the Observatory so important that it must be continued. The galvanic determination of difference of longitude brings with it a mass of

work in negotiations, in preparations, and in calculations; but it produces results of such unimpeachable excellence, and of such value to astronomy and geodesy, that it must in any wise be preserved as part of our system. Time is consumed in experiments for the improvement of our photographic process, and in measures for the multiplication of copies; but these are worthy objects of attention, which it would be wrong to neglect. All these are additions to the labours of the Observatory as they existed a few years ago, unbalanced by any corresponding subtraction.

This increase of labour has been met (or partially met), not by an increase of the number of fixed assistants, but by an increase of the number of supernumerary computers. And this is, in my opinion, the cheapest and the most efficient way of supplying our want. The position of the permanent assistants is in some degree altered by this organisation. Formerly they were simple observers and simple computers: now, without losing the responsibility of personal work, each of them has a subordinate computer, whose work is placed almost entirely under his control. The admirable conduct of all the assistants and computers on the establishment justifies me in saying, that the characters of all parties rise under this arrangement.

I think it quite probable that I may desire from the Government an extension of the discretionary powers under which I have engaged these aids. But I do not at present foresee the necessity of any further increase of our fixed personal staff, or of any other source of important expense. G. B. Airy.

Royal Observatory, Greenwich, 1854, *May* 26.

Lieut.-Colonel De Rottenburg has forwarded from Kingston, Upper Canada, a short communication respecting Comet II. 1854. On the 4th of April he observed it with a telescope by Dollond of $3\frac{1}{4}$ feet focal length. It appeared as bright as a star of the third magnitude. The nucleus was round and well defined. The tail appeared to be about 5° in length, and to have the form of an extremely elongated ellipse. A star of the fourth or fifth magnitude was very distinctly seen through the tail towards its upper and eastern portion.

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